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Linear-regression-based Weighted Centroid Localization Algorithm in Wireless Sensor Network*

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Abstract

Based on establishment of mathematical models,this paper proposed a new localization algorithm based on range-free mechanism which called linear-regression-based weighted centroid localization algorithm.This algorithm improved weighted centroid localization algorithm by the use of hops between nodes, centralizaion and then calibrated the nodes' position by the use of linear regression. Finally, the algorithm corrected the position through certain parameters. On matlab simulation platform, comparing with the original centroid localization algorithm, this new algorithm's average localization error dropped by more than half and localization ratio was increased to close to 1.

Keywords: wireless sensor network; centroid localization algorithm; linear regression; localization error

1. Introduction

For most applications, the datas collected by sensor nodes are meaningless if the localization imformations are unaware[1]. Location information for sensor node must be clear so that we can explain where the particular event happened and track to the external target.Therefore,we must adopt some mechanisms and algorithms for wireless sensor networks to position itself.

This paper studied the centroid localization algorithm[2] short for CLA which is based on range-free mechanism and improved CLA algorithm in view of its huge localization error and low localization ratio in the case of anchor node's low density.Finally, the paper proposed a new localization algorithm called

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linear-regression-based weighted centroid localization algorithm short for LWCLA which combined weight,centralization,linear regression (calibration) and correction.The LWCLA algorithm reduced the average localization error short for *ALE* and improve the localization ratio and its localization performance short for *LP* is more superior.

2. Weighted Centroid Localization Algorithm

2.1. Weighted centroid localization algorithm based hops

Weighted centroid localization algorithm short for WCLA reflects each anchor node's effection to the unknown node's coordinate.Its formulas are usualy as the first step in equations 1[3]. Rencently, most of the existing WCLA algorithms just make refinements to change the weighted factors based on range-based mechanism[4].The range informations are not always reliable and accessable. And it can increase the cost and power comsumption,so they are not the ideal solution.WCLA algorithm used to refine CLA algorithm in this paper was based on range-free model.It reflectd the each anchor node's effection to unknown nodes' coordinates by using the hop information between anchor nodes and unknown nodes.The formulas could be shown as follows.Using formula 1, all unkown nodes can locate themselves by the use of hop and anchor nodes information and localization ratio could increase to close to 1 regardless of the anchor node's density.

$$x_{est} = \frac{\sum_{i=1}^{N} w_i x_i}{\sum_{i=1}^{N} w_i} = \frac{\sum_{i=1}^{N} \frac{1}{hop_i} x_i}{\sum_{i=1}^{N} \frac{1}{hop_i}} ; y_{est} = \frac{\sum_{i=1}^{N} w_i y_i}{\sum_{i=1}^{N} w_i} = \frac{\sum_{i=1}^{N} \frac{1}{hop_i} y_i}{\sum_{i=1}^{N} \frac{1}{hop_i}} \tag{1}$$

Where *N* is the number of the anchor node in the network; w_i represents the weighted factor; hop_i denotes the hop information. The three graphs in first line in figure 1 were WCLA algorithm's results. We could read that all the estimated positions were bias to anchor nodes' center (the average value of all anchor nodes' positions) because of all of the beacon nodes were involves in calculation of each node's estimated positions. This phenomenon could be called centralization effect[5].

2.2. Centralization effect in computing locations

The WCLA algorithm refined in this paper was not perfect, but centralization effect is visible.So this paper added another refinement step in order to strong its centralization effect. It called improved weithted centroid localization algorithm short for IWCLA and its localization process could be summarized as follows. The unknown nodes recorded their estimated positions computed by WCLA algorithm based on hop as their first positions. After that they communicated with their neighbor nodes and accessed their first estimated positions. At last they regarded the average position of their own first positions and their neighbor-nodes' first estimated positions as their final estimated positions. IWCLA algorithm recalculated positions by the use of neighbor nodes' information and expanded the influence of hops adjectively.So estimated postitions computed by IWCLA algorithm were more bias to anchor nodes' center and clarified the centralization effect. Finally,we computed *ALE* and localization accurateness short for *LA* according to formula 2[6]. From formula 2, *ALE* and *LA* is proportional accuracy and that means the lower *ALE*, the lower *LA*,and the *LP* is superior.

$$LA = \frac{ALE}{R} = \frac{1}{R} \times \frac{1}{n_{est}} \sum_{i=1}^{n_{est}} \sqrt{(x_i - x_{esti})^2 + (y_i - y_{esti})^2} \tag{2}$$